



Dropping In a Microgravity Environment

or High School Science in Free-fall



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Outline

- Outline
 - Short microgravity tutorial
 - DIME summary
 - Science in action
 - Promoting DIME
 - DIME feedback and results
 - Conclusions

"To inspire the Next Generation of Explorers As Only NASA Can"

SHORT MICROGRAVITY TUTORIAL

- Microgravity is caused by a free-fall condition
 - Our sensation of “gravity” is the force felt when a floor scale or a chair stops us from falling.
 - If you jump from a tall building with a floor scale, it falls with you and doesn’t stop you from falling - you (and it) are in free-fall and are “weightless”.
- Two GRC drop towers operate with that principle
 - 2.2 Second Drop Tower & Zero-G Facility (a misnomer)



SHORT MICROGRAVITY TUTORIAL

- NASA aircraft create free-fall with a parabolic flight path
 - The NASA C-9 and LearJet follow a path similar to a baseball thrown upward which free falls upward then downward.
 - Astronaut training and experiments are conducted in 15-20 seconds of “weightlessness” during each maneuver on the C-9.
- At International Space Station (ISS) altitudes, gravity is about 90% of 1-g
 - That g-force keeps the ISS falling towards the Earth as it hurtles through space at 17,500 miles per hour.
 - Otherwise, Newton’s laws say it would sail straight off into space
 - ISS and contents are in constant free-fall and the crew float around inside.





Dropping In a Microgravity Environment (DIME) - The Beginning

- The concept for DIME was developed after a middle school tour at the 2.2 Second Drop Tower.
 - Students' questions during the tour prompted the question:
“Why couldn't the students develop ideas and an experiment?”
 - The 2.2 Second Drop Tower is a hands-on type facility with safety features for visitors and it typically operates with ten drops per day.
 - DIME was made for high school students considering the level of maturity and technical competence.



DIME Staff from NASA Glenn

- DIME was conducted by a **team** of Microgravity Science Division **engineers, scientists, and educators**
 - Part-time duty for all
 - Planning and execution by core team of project leader, science lead, and education lead
 - Student-team **mentors** drawn from the microgravity division
 - **Drop tower technical staff** helped to make some experiments 'work'
 - **Safety committee** reviewed experiment hardware each year
- Documents developed over the years
 - DIME instruction manual for annual staff duties
 - Program announcement with rules and rubric for proposal preparation
 - Experiment requirements to help ensure student experiment will interface properly
 - Microgravity resource guide for team advisors (e.g. teacher)



DIME Summary

- Science competition for student teams **nationwide**
 - Fifty states, District of Columbia, and Puerto Rico
- **Conceive, build, and operate** an experiment in NASA drop tower
- Operated for **six** school years between 2000 and 2006
- **Twenty-two** winning teams
 - Ohio (12), Michigan (3), Illinois (2), Oregon (2), Pennsylvania (1), (1), and Florida (1)
 - Eighty-five high-school students & fifteen teachers
- Activities during DIME Drop Days at GRC included experiment **operations**, **webcast** during operations, microgravity **workshops**, GRC **tour**, and **SCUBA** exercise (similar to astronaut training) in hotel pool.
- NASA funded team travel for first five years
 - Transportation, hotel, & per diem for four students and an adult advisor from each team
- DIME funding was cut in 2005
 - 2005/06 teams funded their own travel because the advisors felt DIME was a valuable experience for their students





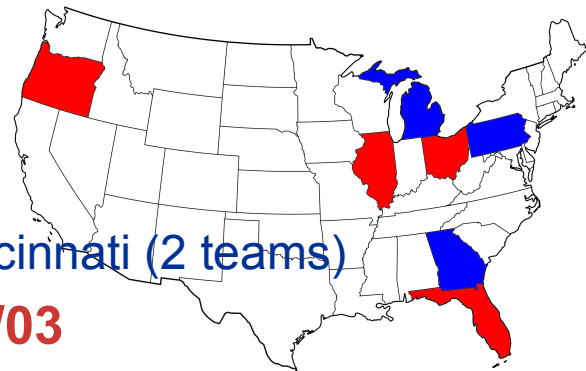
DIME Summary (cont'd)

- Features:
 - Realistic scientific process for high school students
 - School-year-long science program
 - Student team develops a hypothesis and creates an experiment to test the hypothesis
 - Student team develops a proposal according to competition rules and rubric
 - NASA evaluates proposals and selects four winning teams
 - Those four teams design, build and test their experiment
 - NASA provides travel funds for teams to visit GRC and operate their experiment in the 2.2 Second Drop Tower.
 - Student team and NASA mentor analyze data
 - Student team prepares a final report.
- **DIME mimics the process of “real” NASA researchers**

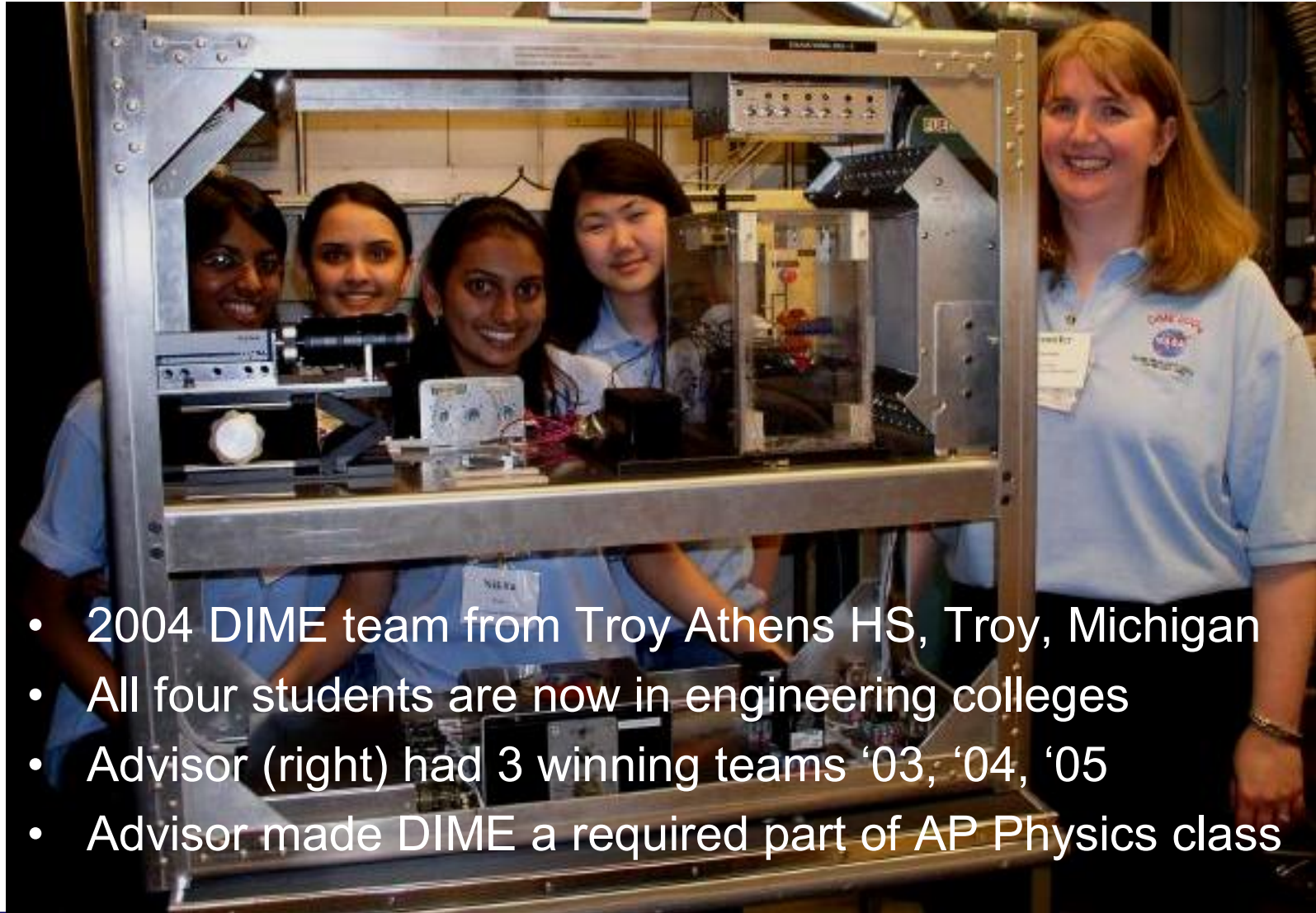


Teams' Locations

- DIME started in **2000/01** school year with a pilot year for Ohio-based schools
 - 2 teams: Columbus COSI & Cincinnati
- DIME opened for regional entries in **2001/02**
 - 4 teams: Columbus COSI, Bay Village, & Cincinnati (2 teams)
- DIME opened for nationwide entries in **2002/03**
 - 4 teams: Gettysburg, PA; Troy, MI; Cleveland Heights; and Cincinnati
- **2003/04**
 - 4 teams: Miami, FL; Troy, MI; Akron; and Cincinnati
- **2004/05**
 - 4 teams: Tualatin, OR; Columbus, GA; Troy, MI; and Northbrook, IL
- **2005/06**
 - 4 teams: Tualatin, OR; Northbrook, IL; Bay Village; and Cincinnati



Team Highlight

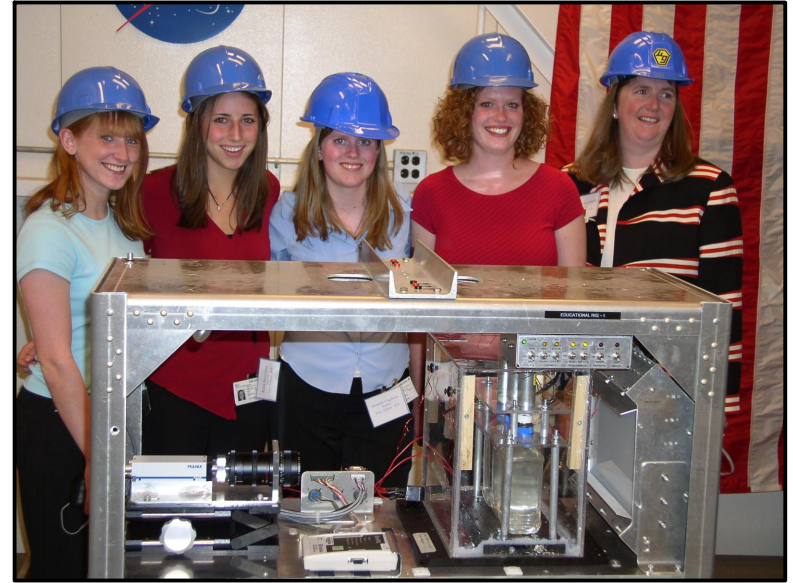


- 2004 DIME team from Troy Athens HS, Troy, Michigan
- All four students are now in engineering colleges
- Advisor (right) had 3 winning teams '03, '04, '05
- Advisor made DIME a required part of AP Physics class

Science In Action



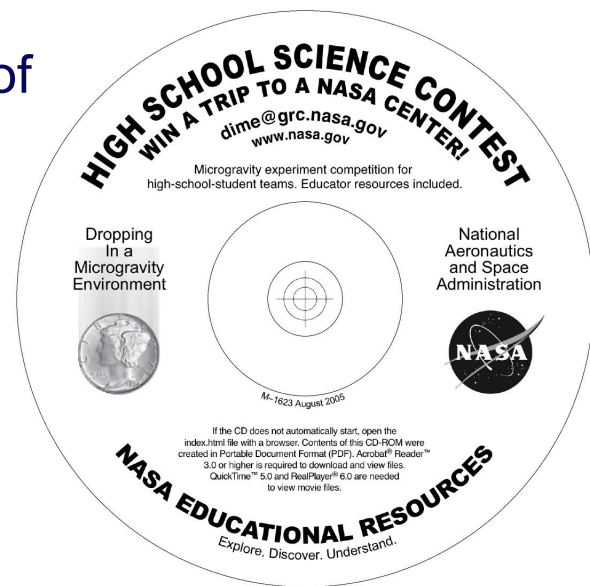
Science In Action





Promoting DIME

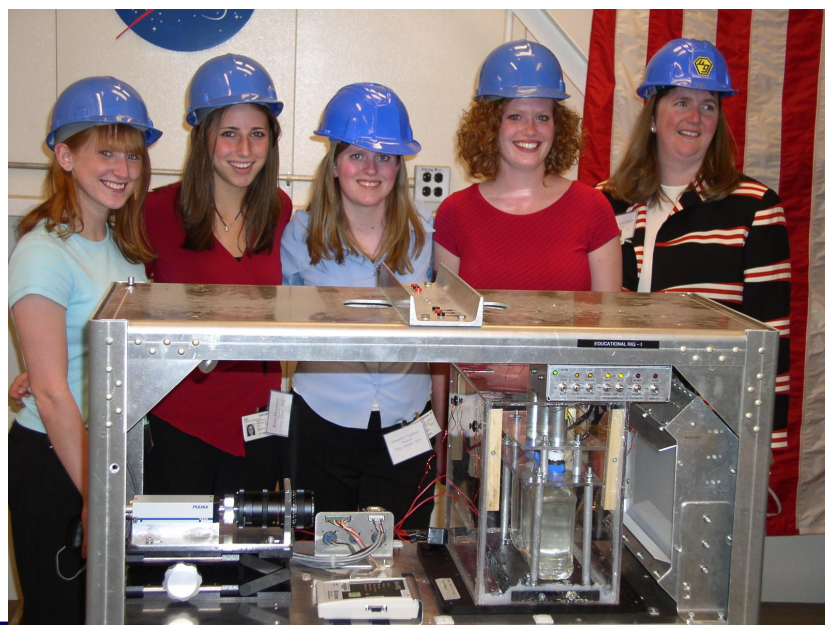
- The **DIME web page** was a primary method of providing information
- A **CD-ROM** was created to convey DIME documents to educators and students
 - Additional NASA and non-NASA educational material included due to capacity of CD
 - Links added for other NASA competitions
 - CD's were produced by the thousands for distribution at educators conferences, etc.
- Web **search engine** entries were developed
- **Direct requests** were made to add DIME to appropriate NASA and non-NASA web sites
 - State-level Space Grant Consortium
 - Science museums
- **Print ads** were placed in science educator organization's national magazine
 - ***The Physics Teacher***



DIME Feedback - Student Comments

- "After **working on our apparatus for 8 months**, when I got to see that it actually worked and that our hypothesis was right, **it was great.**"
- "The **problem-solving**, conducting, and analyzing the results of our experiment were the best parts."
- "I learned most about the importance and effectiveness of **teamwork.**"
- "To do this experiment, you **had to draw upon skills such as team relationship, carpentry skills, science knowledge, and patience.**"
- "Overall, I thought this was great. I had a wonderful time and **can't wait until I'm older and get to do something similar.**"

DIME 2004 team from Troy, Michigan with their experiment installed in drop tower Educational Rig.



DIME Feedback - NASA Co-op Now

- During DIME Drop Days at GRC, a student from Sycamore HS in Cincinnati stated that she **wanted to be an astronaut**. Astronaut Don Thomas happened to visit that year and he talked with her about becoming an astronaut.
- She was part of another DIME team the following year.
- She is now an **aerospace engineering student at Purdue University** and is a **co-op at JSC**.

Date: Mon, 3 Jul 2006

“... It is sad that DIME is over, it is such a great program and I know I got a lot from it.”

“... I have decided that I really enjoy working in this group that operates the shuttle main engines and will probably focus on propulsion in the remainder of my studies at school (Purdue makes Aero engineers pick two areas to focus on and prop is one of the options).”

DIME 2003 team from Sycamore HS, Cincinnati preparing their experiment in a drop tower lab.





DIME Feedback - Educators

- "The two seniors on this year's team are going into **engineering**, one at Purdue University and one at University of Illinois."
- "The DIME program gives students an incredible opportunity to participate in the **process of science in a very personal way!** My students **talked all the way home** about the feelings they had when their experiment **WORKED** for their second and third drops! It was priceless! They said that the **eight months of work that they put into their experiment were absolutely worth it.** We may have four more young people on their way to **careers in research science** because of the DIME experience!"
- "The DIME experience doesn't end with the four girls who were able to attend DIME Days from our school. **Their enthusiasm and excitement have carried over to the rest of the school** - they have told everybody about their experiment and their week at NASA Glenn! I already have students talking about what they're going to **propose next year!**"
- "The three graduates from the team are now at **MIT, John Hopkins, and University of Georgia**"
- "The four young women who were part of the pilot DIME program are all sophomores in college (ca 2003) and all are **majoring in engineering.**
 - Aerospace at Michigan Aerospace at Virginia
 - Mechanical at Rose Hulman Electrical at Villanova"

DIME Feedback - Astronaut

From: "THOMAS, DONALD A. (JSC-CB)"

Subject: New co-op arrives at JSC

Date: Fri, 26 Aug 2005 10:56:38 -0500

Hi Dick,

I just went over to visit with Christine, one of your DIME graduates and now a new co-op student here at JSC. She just started on Monday and I found her working away on some computer program for lunar landings already. I think she is pretty excited to be here! I will keep an eye on her and make sure she gets some special tours of JSC. Maybe she'll invite you and me to her first launch in a few years !!

Don



DIME 2003 'graduation' with Don Thomas and Christine (second from right)



DIME Alumni & Connections

- Examples of feedback from DIME 'alumni'
- A student attending U of Michigan had this to say about **her team** (from a Detroit suburb) and the **three other teams** from DIME 2005:
 - *"There is a new website that connects all the college kids across the United States so Kim, Lauren, Amanda, and I have been able to **keep in contact with the students from Oregon, Georgia, and Illinois**. It has been a lot of fun to chat with them even just over a computer this summer!"*



DIME 2005
participants and
NASA staff



DIME - The End

- Fundamental research in microgravity science has been de-emphasized in recent years
 - Not eliminated, but focused on exploration needs for return to the moon and missions to Mars
 - Funding for DIME was not continued with 'demise' of Microgravity Program Office
- For school year 2005/06, four teams funded their own travel to visit GRC and operate their experiments
 - Advisors felt DIME was a valuable experience for their students based on their past participation.
 - Participation was from teams in:
 - Bay Village, Ohio (no surprise!)
 - Cincinnati, Ohio
 - Northbrook, Illinois (wow!)
 - Tualatin, Oregon (WOW!)
 - They left feeling glad they had participated!



Conclusions

- NASA needs to engage young people in Science, Technology, Engineering, and Mathematics (STEM)
 - A major agency education goal is to attract and retain students in STEM disciplines.
- DIME was successful in engaging students in STEM activities.
- NASA Ames patterned a centrifuge student competition after DIME.
- Challenge for facility managers at Glenn:
 - Could your facility serve a similar educational purpose?
 - Could your facility be used “virtually” as an on-line model?